UNITED STATES ENVIRONMENTAL PROTECTION AGE[redacted]

SUBJECT: Trip Report for Pulp and Paper Delegation to the Soviet Union April 12 - April 27, 1975

FROM: Andrew Paretti, Head of Delegation, Office of Water Program Operations WH-447

TO: Fitzhugh Green, Associate Administrator for International Activities A-106

John T. Rhett, Deputy Assistant Administrator for Water Program Operations WH-446

James L. Agee, Assistant Administrator for Water and Hazardous Materials HM-556

Three years ago President Nixon signed an agreement with the Soviets which would provide for cooperative programs in several non-critical areas. One of these was the space program which has been well publicized. Another area designated for cooperative programs involved the environment and specifically water pollution control.

In 1974 the Soviets sent a team of pulp and paper experts to the U. S. to visit various pulp and paper mills which were providing primary and secondary treatment and in some cases tertiary treatment. A reciprocal visit by U. S. experts to the Soviet Union for the examination of wastewater practices in the paper industry was conducted from April 11 through April 27, 1975.

During the Soviet tour four pulp and paper mills, several ministries, design institutes and numerous institutes responsible for the maintenance of water quality were visited.

Those making the tour were as follows:

1. Andrew Paretti, Consultant, Water Program Operations, EPA, Chief of Delegation

2. Ralph Scott, Chief, Paper and Forest Industry Research, EPA, NERC

3. Isaiah Gellman, Technical Director, NCASI

4. Herman Amberg, Director, Environmental Services, Crown Zellerbach

5. Anthony Beliajeff, Interpreter, State Department

EPA Form 1320-6 (Rev. 6-72)

Approved For Release 2005/04/12 : CIA-RDP79-00798A000800060002-2

25X1

Program

of the reception of the delegation of American specialists in the field of prevwntion pf water pollution by pulp and paper industry.

April 12 Saturday	-	Arrival at "Sheremetjevo" airport fli PA-102; 13.20 h.
April 13 Sunday	-	Free day Excursion Kremlin Visit.
April 14 Monday	-	Meeting at the Ministry of Cellulose Industry Leaving for Leningrad express-train No 22.55h Visit GUM + Red Square
April 15 Tuesday	Victor Shaseev Dept. Manager GIPROBUM -	Arrival at Leningrad Meeting at the State Institute of Disigning of Pulp and Paper Plants. VISIT Hermitage + Sightseeing
April 16 Wednesday	-	Meeting at the All-Union Scientific Resea@chInstitute of paper Krasnogorod Experimental paper Plant. Leaving for Moscow, express-train No. 23.55h.
April 17 Thursday	-	Arrival at Moscow, at 08.30h Leaving for Irkutsk, "Domodedovo" Air Flight-123, 12.00h Arrival at Irkutsk, 18.59h (23h.59 min time)local)
April 18 Friday	-	Meeting at the Siberian State Institut of Designing Pulp and Paper Plants Irkutsk.
April 19 Saturday	-	Flight for Bratsk Flight 3757 at ~~03.30h~~ (8.30h-Local tir VISIT Bratsk Forest Industry Co

April 20 Sunday	- Visit ~~Bratsk Forestry Industry Complex~~ Bratsk Hydro Electric Station 4500 megawatt, Large Aluminum
April 21 Monday	- Returning from Bratsk to Irkutsk Flight B-905 (8.30h local time) Visit Baikal Limnological Institute Lake Baikal.
April 22 Tuesday	- Baikal pulp mill (early in the mornin Baikal expedition of the Hydrochemical Institute Returning to Irkutsk (late in the eveni Left 0900 Return 0200
April 23 Wensday	- Leaving for Moscow, Flight CY-564, 09.55 h Arrival at Moscow 17.40h
April 24 Thusday	- Leaving for Kherson "Vnukovo" airport Flight 1677, 14.04h Arriva l at Khersan, 16.59h
April 25 Friday	- Kherson pulp mill Leaving for Kiev, train No.220, 20.29h
April 26 Saturday	- Arrival at Kiev, 10.04h the Ukrainian Scinbific Research Institute of Paper. Leaving for Moscow by train No.2. 21.20h (Missed Flight)
April 27 Sunday	- Arrival at Moscow, 9.00h Leaving for the USA from Sheremetjevo Airport, flight PA-93 at 11.35h

RESULTS AND DISCUSSION

A. Ministry of Cellulose Industry, Moscow (Monday, April 14, 1975)

We visited the offices of the Ministry of Cellulose Industry on Monday and were welcomed to the USSR by Deputy Director, N. Chistiakov and his staff. This is a primary ministry reporting directly to the Councils of Ministers and is responsible for the pulp and paper industry. An organization chart is shown in Figure 1.

The Deputy Minister pointed out some of the problems facing the Soviet pulp and paper industry, most of which sounded familiar.

First, prior to construction of new plants, approval must be received from a great many ministries and construction cannot be started until all of the necessary signatures have been received. This can, in many cases, involve several years of negotiations and is ultimately settled by negotiatio amongst the various ministries involved. The problems sound quite similar to those involved in obtaining approval to start a new project under the National Environmental Policy Act in the U.S.

The Soviets are also concerned about the very high capital and operating costs associated with their present water pollution control program. A rough estimate indicates that about 12 to 14% of the capital for a new project is being spent on water pollution control facilities and operating costs are about 15% of total plant production costs.

The ever-changing water quality and effluent quality requirements were also cited as adding to costs. These ever-changing requirements have prompted the Ministry to undertake a study of its own to determine the impact of pulp and paper mill discharges upon the receiving waters.

Special situations arise in the Soviet Union, because of the extreme cold, which necessitate greater degrees of treatment than in other countries. For example, many Soviet streams are covered by ice for at least four to six mont Unless most of the BOD is removed, dissolved oxygen will be depressed below t desired levels. In many cases, in addition to treatment, holding ponds must provided to hold the effluent during that period when the streams are frozen.

They are particularly interested in new technology that would reduce the poll tants produced, such as oxygen bleaching, closed cycle operation, etc.

The Deputy Director also mentioned that they were interested in signing agree ments with foreign companies to obtain new technology. In fact, most of the new mills that have been built in the last ten years and those proposed will be equipped with Western machinery. Kamyr continuous digester, diffuser wash etc., are widely used in new construction. Also mentioned was the negotiatio underway with International Paper. In fact, the Ministry had a meeting with representatives of I.P. on Friday, April 25. Whether an agreement was signed not known. The plans call for the construction of a forest complex by I.P. o the Yenesey River in eastern Siberia which would utilize about 212,000,000 cu

of wood per year. I am assuming that about 500,000 tons/year of dissolving pulp will be produced as well as lumber, veneer, yeast, etc. Repayment will probably be in wood or pulp since money does not leave the country.

B. The State Institute for the Design of Pulp and Paper Enterprises (GIPROBUM), Leningrad (Tuesday, April 15, 1975).

Giprobum is the primary design institute for the Soviet pulp and paper indust There are four other design institutes which operate independently and report directly to the Ministry of Pulp and Paper. The other institutes are located in Moscow, Kiev, Riga, and Irkutsk (See Exhibit II).

Giprobum, Leningrad, employs some 1,000 engineers who conduct feasibility studies and design the pulp and paper complexes. They also contract out certain portions to other organizations and work quite closely with the Scientific Research Institute of Pulp and Paper to make sure that the latest technology is used.

It was pointed out that the Soviet Union in 1974 produced about 11 million tons of pulp and paper and used about 282 million cubic feet of water. At this time, about 30 pulp and paper mills produce 70% of the production and ha secondary treatment. Emphasis is being placed on new technology to reduce wa usage.

Although treatment is required at all mills, it is not uniform, i.e., sensiti areas require higher degrees of treatment than non-sensitive areas. The following is a summary of the external waste treatment requirements generally followed:

a. Complete Biological Treatment by Activated Sludge:

Activated sludge treatment is used to treat the wastes from large mills having a BOD of 100 to 400 ppm. In this case the BOD will be reduced to 10 to 25 ppm or 90 to 94% and the suspended solids will be reduced to 20 to 25 ppm.

b. Activated Sludge Treatment Plus Aerated Stabilization Basins:

This somewhat higher degree of treatment is applied to effluents containing 100 to 400 ppm of BOD and where an effluent of high quality and stability is required. The residual BOD in this case will be about 7 to 10 ppm and suspended solids about 20 to 25 ppm. The BOD reduction will range from 93 to 97%.

c. Mechanical Clarification and Chemical Treatment:

This treatment sequence is applied to small paper mills and board mills. The initial BOD is usually about 40 to 80 ppm and treatment will reduce it to 30 to 65 ppm. Suspended solids will be reduced to 4 to 8 ppm.

d. Activated Sludge, Chemical Treatment and Aerated Stabilization Basin Treatment:

This high degree of treatment is generally applied to those large mills on sensitive receiving streams or lakes. In this case, BOD is reduced to 5 to 10 ppm (95 to 97% reduction) and suspended solids are reduced below 10 to 15 ppm.

More or less, standardized treatment has been developed which is used throughout the Soviet Union. Some of the designs do not use primary treatmen but all activated sludge treatment plants are preceded by equilization basins These basins are aerated and carry about 500 to 1000 mg/l of mixed liquor suspended solids. Retention may vary from several hours to 12 hours and partial BOD reduction is accomplished in these units.

Clarifiers are circular and primary units generally remove about 70% of suspended solids and provide a retention of 2 to 4 hours. They have standardize on three different diameters: 92 ft., 131 ft., and 164 ft. Secondary clarifiers as well as primary units, have peripheral drives such as the Passavant units in this country.

Aeration basins are generally equipped with diffuser plates on the bottom of the tanks. Although they have tried mechanical aerators, they have not been able to build trouble-free units. Air is supplied at a rate of about 20 to 27 cu. ft./lb. BOD removed/day.

Aerated stabilization basins in the Soviet Union are generally used as polish devices and follow the activated sludge basin. About 24 hours of retention i provided in this application. At small paper mills, the aerated stabilizatio basin may be the sole treatment.

Sludge treatment is not widely used in the Soviet Union but in their new desi they plan to thicken, mechanical dewater, dry and burn the sludges in the bar boilers. Dewatering of activated sludge has been a difficult problem and the generally use chemical conditioning agents to filter the material. Chemical usage for sludge filtration runs about 10 to 20% of the weight of activated sludge.

1. Ust-Ilimsk Project: Giprobum has designed the Ust-Ilimsk bleached kraft mill which they described. This mill is located on the Angara River in eastern Siberia, about 100 miles north of Bratsk and will be operational some time in 1977 - 1978. Total design capacity is 550,000 tons/year (500,000 metric tons). I am assuming that mill construction was started in 1973. Continuous digesters are being used as well as diffuser washing. Water usage is expected to be about 33,000 gal/ton or about 47 million gallons/day. A schematic diagram of the treatment facilities is shown in Figure 2.

The effluent from the mill goes through coarse screens and is pumped to the two equilization tanks. One of these tanks is equipped with mechanical aerators and the other with diffuser plates. Primary

treatment is provided by eight clarifiers which remove 70% of the suspended solids and 15 to 20% of the BOD. There are five aeration tanks. Three of these units will be equipped with mechanical aerators and two with diffuser plates. Ten secondary clarifiers are being installed and the primary and secondary sludges are thickened and dewatered on vacuum filters. Present plans call for drying of the sludge and burning it in a bark boiler.

Although most existing mills are doing little to control air emissions, the Ust-Ilimsk mill will have adequate controls. Steam stripping of digester and evaporator condensates is planned and the malodorous gases from the digester and evaporators will be collected and burned in an incinerator. The recovery furnaces will be equipped with a precipitator followed by a venturi scrubber and the bark boilers will be equipped with mechanical multiclone collectors. Lime kiln gases will be water scrubbed. The recovery boiler and power boiler gases will be discharged from 394 ft. tall stacks.

To handle spills, about 30 to 40% additional evaporator capacity is being provided to permit return of weak black liquor spills from the spill collection basins.

C. All-Union Pulp and Paper Industry Scientific Research and Production Complex, Leningrad (Wednesday, April 16, 1975)

The General Director, E. J. Petchko, briefly outlined the functions of this group. They employ some 1700 people in seven different research centers throughout the Soviet Union. They also run the experimental paper mill at Krasnogorod, outside of Leningrad.

About 130 people at the Institute are working on pulp and paper mill wastewater treatment. Their work is closely coordinated with Giprobum and they report to the State Committee of Science and Technology.

The first stage of their program was heavily oriented toward external waste treatment since the job of cleaning up their streams had to be done in a hurry. The second approach of internal measures to control pollutants would take much too long and would require extensive rebuilding of existing plants. From an economic and time standpoint, it was decided to proceed as rapidly as possible with the external treatment approach.

They have now come around to looking at a combination of internal and external controls. In the near future they plan some mill scale trials of various procedures for closing the water circuit. They are aware of the possible problems associated with mill closure and believe that some of these effects can only be studied in the mill.

Considerable work is also underway on the utilization of sludges, particularl activated sludge. Research is underway designed to utilize sludge for agricultural applications. They are also looking at the possibility of combining the activated sludge with yeast and selling it as animal feed. However, when activated sludge is treated with chemicals for dewatering, problems can be anticipated. There is a tremendous shortage of protein in the Soviet Unio and protein such as yeast demands a relatively high price. For example, a metric ton of yeast sells for 400 rubles (25 cents/lb.).

This appeared to be one of the least informative meetings we had on our trip.

D. Krasnogorod Experimental Paper Plant at the All-Union Scientific Research Institute of Paper, Krasnogorod (Wednesday, April 16, 1975)

This plant is available to the Scientific Research Institute and is used for experimental trials to develop the necessary information for the production of various specialty papers. Experimental pulping and bleaching facilities are available as well as a small paper machine.

The mill has four small, old paper machines which produce specialty papers, such as metallized papers, business form papers, filter papers, carbon papers overlays, etc. About 13,000 metric tons (14,300 U.S. tons) are produced per year which in 1974 were sold for 13 million rubles or $18.2 million. It provides employment for about 900 people.

The mill dates back to 1714 when it was commissioned by Peter the Great. It was completely destroyed in World War II. The machines look like they may have come from Germany as reparation payment after World War II. Plans are underway to modernize the mill with new machines and equipment.

The mill uses about 1.9 million gallons/day of water or 46,341 gallons/ton. Water reduction programs are planned which would reduce usage to 30,000 gal/t Water is taken from a small lake at the site which is supplied by springs. Tl paper machine white waters are pumped to a conical clarifier similar to a Mar Saveall, where settleable solids are removed. The settleable solids removed flow to thickening tanks and the clarified effluent is pumped to sand filters for filtration. Alum is used as a chemical coagulant. The backwash from the sand filters flows to thickening tanks where it is combined with the water treatment plant sludges and the Marx Saveall sludge. The sludge is pumped to lagoons for storage and the clarified effluent is returned to the lake.

E. Siberian State Institute for the Design of Pulp and Paper Plants, (SIBGIPROBU Irkutsk (Friday, April 18, 1975)

Irkutsk is about 3500 miles or five time zones east of Moscow and is located on the Angara River, below Lake Baikal. The population is about 500,000 and industry consists of a large aluminum plant and several metalurgical plants. There is a university in the city, as well as a number of other technical institutes. The Director, Mr. Chernoval, briefly described several mills which they are working on.

1. Selenga Mill: The Selenga Mill is located on the Selenga River, about 200 kilometers upstream of Lake Baikal. The Selenga discharges into Lake Baikal and has an extensive run of Omul, a very desirable species of fish and found only in Lake Baikal. In September, the Omul go upstream to spawn and return to the Lake in November. About 98% of the spawning occurs above the mill, but fish must migrate past the mill. The fingerlings return to the Lake in April. When the fingerlings move downstream, discharge is stopped for 20 days in April to permit safe passage. This requirement was imposed by the Ministry of Fisheries.

Because of the migratory fishery and nature of Lake Baikal, a very high degree of treatment is being provided by this mill.

The mill has two lines to produce 280,000 metric tons (308,000 tons) of linerboard. The first line is in operation and the second is under construction. Since this is a seismic area, batch digesters were used (10 units). There are two pulp wash lines employing 3 stage washing. Another stage is needed to reduce the load going to the treatment plant. Design calls for two linerboard machines to produce about 150,000 U.S. tons/year each. Design calls for the use of 19 million gallons of water/day or about 22,000 gal/ton of board.

Three recovery furnaces have been built, having a capacity of 350 tons of solids/day for each unit.

The requirements of this mill are similar to those imposed on the Baikalsk Mill and the following is a short description of the treatment facilities provided. The treatment plant was built to handle the total capacity of the plant.

The effluents from the mill are pumped directly to aerated stabilization basins (no primary) and from there they flow to the activated sludge plant. The activated sludge effluent is alum treated for color removal. The final effluent is not filtered through sand filters but discharged directly after neutralization to an aerated stabilization basin using surface aerators (24 hours). The treated effluent is then discharged to the Selenga River by means of a diffuser outfall suspended above the surface of the water. Discharge is about 2 to 3 feet above the surface of the water.

Alum treatment for color removal produces large amounts of sludge. The sludge is thickened in lagoons from 0.3% solids content to about 2% consistency. The waste activated sludge is also ponded. A system is being built at Baikalsk for the dewatering and treatment of the chemical sludge. If successful, the system will also be installed at this mill.

The following design parameters were used for the final effluent quality: BOD, 6 ppm; suspended solids, 7.5 to 10 ppm; color < 100 pp

We questioned the group about the problems encountered by eliminating primary treatment and were told that the savealls provided a waste to treatment containing less than 100 ppm of suspended solids and as long as the suspended solids were that low, no difficul were experienced in running the rest of the plant.

The effluent from the treatment plant has a BOD of 4.5 ppm and less than 10 ppm suspended solids. BOD into the treatment plant is about 250 ppm and suspended solids, 75 ppm.

The supernatant from the sludge storage ponds is pumped back to the treatment plant. The standards for the Selenga River are as follows:

Suspended solids allowable increase	<	0.25 ppm
BOD allowable increase	<	2 ppm
Dissolved Oxygen	>	6 ppm

Treatment efficiency has been good in the winter and wastewater temperature has been above 10°C (50°F) during the cold months.

2. Komsomolsk Mill: This mill is located on the Amur River, a very important fish producing stream. Considerable effort has been expended in wastewater treatment facilities. Air and water pollutants have been reduced to an absolute minimum. This mill produces sulfite pulp for viscose. They also have a sulfate mill and NSSC mill to produce linerboard and medium. The sulfite liquor and NSSC liquor are burned in one system and the chemicals are then used in the sulfate mill for chemical make-up. Because of ice, the highly treated wastes are impounded during the winter and discharged in the spring. Yeast is also produced at this mill from the sulfite liquor.

We were not given information on size or details of the treatment system but treatment is probably quite similar to that provided at Selenga.

F. Limnological Institute on Lake Baikal (Monday, April 21, 1975)

The Limnological Institute is located at the southern tip of Lake Baikal about 37 miles from Irkutsk. This institute coordinates the work of a number of groups working on Lake Baikal. We were given background information on the Lake which was most interesting.

Lake Baikal is about 420 miles long and 46 miles wide. It is the largest fresh water lake in the world containing 20% of the world's fresh water. Over 300 rivers empty into the Lake and only one, the Angara, carries the overflow. The lake at its deepest part is 5300 feet deep. Currents in the lake are highly variable and can go either north or south. Some 1800 different species of animal and plant life are found in the lake, 75% of which are found only in Lake Baikal. No fish leave the lake by means of the Angara River and because of the hydroelectric plant at Irkutsk, no fish can enter.

Poor logging practices in the past wiped out many spawning areas in the tributary streams discharging into Baikal. These practices have been controlled, the streams cleaned of logs and the fishing resource reestablished by hatcheries. Movement of logs on the lake is forbidden and logging is forbidden in a buffer zone 8 miles from the shore.

G. <u>Bratsk Forest Complex (Saturday, April 19, 1975)</u>

Deputy Director, N. S. Sjabrenko, showed us around the Bratsk area which is about 400 miles northwest of Irkutsk. This development is typical of the newer developments in Siberia.

A hydro project was first built at Bratsk from 1955 - 1967. There are 18 Francis turbines having a capacity of about 4100 megawatts and generating 28 billion kw - hr/year. The reservoir behind the dam covers 5.4 thousand square kilometers and supplies the power for a very large aluminum plant at Bratsk as well as the forest complex.

Development in the area has been rapid since completion of the power plant in the mid-60's. Today, Bratsk has a population of 200,000 and apartment houses are going up everywhere.

We were told that it was very difficult to get skilled workers and that a premium of 40% was required to get people to come to eastern Siberia. They are considering raising the bonus. A bonus of 20% is paid in Irkutsk. We were also told it was difficult to keep technical people. After receiving their university training, they have to accept an assigned position for three years but after that they can go anywhere. It has been the general practice to leave Siberia after three years. The shortage of skilled labor is evident everywhere throughout the Soviet Union.

The Bratsk Forest Complex will probably be the largest in the world upon completion. It will upon completion utilize 247 million cubic feet of wood per year. This will be a totally integrated operation when completed. Logs are brought in on the Bratsk reservoir since the mill is built on the reservoir. Choice of the site was dictated by the large raw material base (scheduled for 80 year rotation), readily available rail and water transportation, good water quality, and cheap electro power.

The design capacity of the pulp mill is 1,100,000 tons/year. Phase 1, which has been completed and is operational, has the following capacity: 220,000 tons of tire cord rayon, and 275,000 tons/year of linerboard. Phase 2, which has just started up, has the following capacity: 275,000 tons of bleached cellulose and 220,000 tons of viscose cellulose. Difficulty has been experienced in the bleach plant of Phase 2 and they are making linerboard until their difficulties are resolved. The bleach plant for the dissolving grades has 11 stages.

They also have facilities for the production of tall oil, turpentine, yeast and extraction of stumps. The yeast plant produces about 25,000 tons/year from the prehydrolysis liquor. Plans call for expanding the yeast plant to 110,000 tons/year using acid hydrolysis of waste wood (small chips). A sawmill produces 14,000,000 cu. ft. of lumber/year. A mill to produce 7,100,000 cu. ft./year of veneer is under construction and a hardboard plant having a capacity of 430,000,000 ft^2 is also under construction. The wastes from the plywood mill will be used to produce the fiberboard and chips from the sawmill will be used in the pulp mill. The total cost of the completed combine is 1.3 billion rubles or $1.82 billion. At present, 13,000 people are employed and this is expected to go to about 23,000 people upon completion

Again, the major pieces of equipment in the mill are foreign made. We walked through one part of the mill which was operating. There were two KMW pulp driers having a total capacity of 220,000 tons/year. The linerboard machine was made by Tampella.

The treatment plant was one of the largest I have ever seen and treats 177 to 197 MGD. It looked sufficiently large to treat the effluents from a city as large as Chicago and must have covered several square kilometers. The concrete work and buildings looked about 50 years old. The concrete was deteriorating and the general workmanship was unbelievably poor. Everything appears to be falling apart already. About 200 people are employed at the treatment plant.

Those effluents with high suspended solids go to 10 radial primary clarifiers having a diameter of 131 feet and a volume of 1.32 million gallons. Suspended solids removals are about 60 to 70%. Incoming suspended solids range from 250 to 300 ppm and outgoing concentrations are about 90 to 100 ppm.

Biological treatment station No. 1 receives the pulp mill wastes and the bleach plant alkaline extract (63 to 76 MGD). The first unit is an equilization tank of about 11 million gallons capacity. This unit is aerated with diffusers and has a mixed liquor suspended solids concentration of about 800 to 1000 ppm. The effluent then flows to 11 aeration tanks each having a capacity of 2.1 million gallons. There are six secondary clarifiers having a diameter of 131 feet. The effluent into this plant has a BOD of 273 - 300 ppm and the effluent 8 - 12 ppm (96 - 97% reduction). One of the aeration basins serves as a reaeration basin for return activated sludge.

Biological Treatment Station No. 2 handles the remaining wastes. This plant has an aerated equilization tank of 14 million gallon capacity. There are five aeration tanks and 10 secondary settling tanks. The waste sludges from both stations go back to the primary treatment plant. At present, the common discharge contains 12 to 14 ppm of BOD, 18 to 19 ppm suspended solids and a dissolved oxygen of 5.8 to 6.4 ppm.

They are now constructing an effluent polishing system of three lagoons to provide a retention of 24 hours. Aeration will be with surface aerators. Seven rectangular and six radial clarifiers will be provided for final clarification. The BOD leaving the system is expected to be 7 ppm and suspended solids 10 ppm.

The final treated discharge is into a small river which joins the Angara River 60 miles downstream. The total flow through the entire treatment system is 177.5 MGD to 197 MGD. The energy utilization of the treatment plant is 30,000 kw and will go to 45,000 kw upon completion. Water usage for the linerboard is about 29,000 gal/ton and 144,000 gal/ton for the cord pulp.

Air pollution controls are limited to particulate matter control. There is no odor control system. The two recovery furnaces are equipped with electrostatic precipitators followed by wet scrubbers. Overall efficiency is about 98%. The lime kilns are equipped with wet scrubbers operating at 94 to 95% efficiency. There are six bark boilers which are equipped with wet scrubbers. There are also two coal fired power boilers operated by the Electric Ministry which provide hot water to heat the homes in the community of Bratsk. The pow boilers and recovery furnaces discharge through 238 foot stacks and the lime kilns through a 262 foot tall stack.

In walking around the plant, some general observations can be made. It become apparent that the treatment facilities are substantially oversized. Operation within the mill apparently are very sloppy as far as water usage and control of BOD are concerned, and treatment facilities are built large enough to handl all contingencies. The treatment plant cost 100 million rubles or $140 millio This figure could easily be reduced by 50% by better internal housekeeping. Employment is unbelievably high but this is probably necessary when we conside the size and complexity of the treatment plant.

Workmanship of the treatment plant and buildings was unbelievably poor. The facilities looked as if they were fifty years old. Redundancy is built upon redundancy. Considerably savings could also be affected by increasing the size of primary and secondary clarifiers. There appears to be no tremendous incentive to reduce costs. Those involved in the design build the plants sufficiently large to cover all contingencies.

Considering that the mill was started some ten years ago, it was unusual not to have any paved roads around the mill yard. It was a sea of mud and it appears that all of the junk is thrown out into the mill yard.

BOD and suspended solids appear to be very low since all data are reported on a ppm basis. However, when the data are converted to daily loads, the BOD load is 20,300 lbs/day (6.5 lb/ton) and the suspended solids load is 28,072 lbs/day (8.93 lb/ton). Abnormally high water usage in the USSR results in low concentration levels and this must be taken into consideration when making comparisons.

Throughout our trip we also heard rumbles of start-up problems which last years. Lack of skilled labor adds to the problem.

H. Baikalsk Pulp Mill Complex, Lake Baikal (Tuesday, April 22, 1975)

The Baikalsk Mill is located on Lake Baikal and discharges directly into the Lake. Director, Alexander Sentchenco, made the tour of the U.S. industry in 1974 and showed us around the mill. The town of Baikalsk has a population of about 13,000 people.

Total capacity of the mill is 220,000 tons of dissolving grades. There are two lines, each having a capacity of 110,000 tons. The first line produces tire cord pulp and the second viscose pulp. Final construction is not yet complete and some changes are being made in the nine stage bleach plant. They are producing bleached kraft pulp until these difficulties are resolved. Water usage for both lines is 76 MGD or about 121,000 gal/ton.

Wood is brought in from a distance of about 400 miles by rail since logging adjacent to the lake is forbidden. I got the impression by talking to several people that selection of this site was a mistake. There is a wood preparation plant and dry debarking. The chips are stored in concrete chip silos. There are 24 batch digesters. Nine stages of bleaching have been provided.

The power complex consists of nine boilers, three power boilers burning local coal, two bark boilers, and four recovery furnaces. One more recovery furnace has been proposed. The power plant also produces hot water and power for the town.

In addition to pulp production, about 16,000 tons/year of yeast, 11,000 tons/year of wrapping paper from screenings, 11,000 tons of tall oil and 3,300 tons/year of turpentine are produced.

Raw water is pumped from the Lake and is screened on Passavant rotary filters. The boiler feed water and the final slurrying water for pulp is deionized.

No more expansion is contemplated at this mill. The first line was started in 1966 and the second line in 1969. The mill employs 3,000 people with 200 working at the effluent treatment plant. Operating costs for the treatment plant are about 15% of production costs. The treatment plant cost 30 million rubles ($42 million) and an additional 7 million rubles ($9.8 million) have been allocated to build a chemical sludge dewatering and treatment system. Th workers at Baikalsk are paid a 40% premium.

The waste treatment facilities are very complex and a simplified flow sheet is shown in Figure 3. The strong wastes are segregated and treated in a separate biological treatment plant (pulp mill wastes and some of the bleach plant caustic extract). The effluent going to this plant contains up to 1000 ppm of COD compared to 100 ppm for the second plant. The BOD into the small plant is 400 ppm and the effluent leaving the plant is 4 ppm. The large plant has an incoming BOD of 100 ppm and outgoing BOD of 6 ppm.

Equilization basins precede the activated sludge plant. The small plant handling the concentrated effluent provides a retention of 16 hours and the on for the large plant some 6 hours. About 1000 ppm of mixed liquor suspended solids are carried in the equilization basin. The equilization basins are aerated with diffuser aerators and are completely mixed. The small plant trea about 20% of the waste load.

Temperature has not affected the performance of the plant even when the Januar and February ambient temperature drops below -33°C. The wastewater temperatu does not drop below 8°C which they consider to be the critical temperature. T plant will not operate properly below 8°C.

They also reaerate the return activated sludge from the secondary clarifiers for about 3 hours prior to return to the aeration tanks. This practice has been questioned. The mixed liquor suspended solids in the activated sludge aeration tanks is about 3000 ppm. About 6 hours of aeration is provided in th aeration basin handling the weak waste. There are 5 secondary clairifers havi a diameter of 131 feet and volume of 1.2 million gallons each.

Initially, they built a separate plant for handling the waste activated sludge which consisted of two thickeners having a diameter of 79 feet followed by two Eimco belt vacuum filters (430 ft^2/filter). The feed to the Eimco filters was about 2% and the consistency of the sludge leaving was 15%. Lime was added to aid filtration. The sludge then dropped down to two rotary kiln driers fired by oil where it was dried. Initially, they wanted to sell the dry material for animal feed but they found that the drying temperature was too high and long which resulted in the destruction of some of the nutritive values. The presen of the dewatering chemicals also presented a problem. They no longer use the activated sludge dewatering plant, which probably cost about 2 million rubles or $2.8 million, but bypass the low amount of activated (about 7 tons/day) to the chemical plant. Settling of the activated sludge must be very poor since they only have about 7 tons/day of waste activated sludge from the secondary clarifier. This is probably also typical of operation at other plants and explains the reason for the use of lagoons and aerated basins following the co ventional activated sludge plants. For example, this mill is producing at least 100,000 lb/day of BOD and should have at least 50 tons/day of waste biological sludge. They are collecting only 14% in their secondary clarifiers. The overflow rates for the secondary clarifiers are quite high (1169 gpd/ft^2) which explains the high carryover of sludge.

The effluent from the secondary clarifiers, which contains most of the activated sludge suspended solids, is then pumped to the alum color removal plant.

There are six reactor clarifiers for the alum color removal system, each having a diameter of 177 feet. The overflow rate for these units is calculated at 507 gpd/ft^2. Alum and polyacrylamide are added at a dosage rate of about 250 to 300 ppm at $Al_2(SO_4)_3 \cdot 18\ H_2O$ containing 13 to 15% Al_2O_3 and about 1 to 2 ppm acrylamide. One tank car of alum is used per day or about 50 tons. The effluent from the color removal process is very light yellow in color and contains about 60 to 70 color units. The alum sludge, along with the waste activated sludge, goes to ten sludge lagoons at a concentration of about 0.3% solids. There are about 99 tons/day of bone dry alum sludge and 7 tons of activated sludge from the secondary clarifiers.

They were operating a sludge dewatering pilot plant consisting of a flotation thickener followed by an eight pass belt pressure filter (vertical) having a 269 ft^2 filter surface. These units are manufactured by the Russians in the 269 ft^2 and 538 ft^2 sizes. They operate at eight atmospheres (118 psig) and produce 0.5 lb. of cake/ft^2/hour at a final consistency of 30%. The flotation unit increased the solids content of the alum sludge from 0.3% to about 4% and this 4% consistency sludge was then fed to the belt filter. We were told that the 25 square meter (269 ft^2) units cost about 30,000 rubles in Russia ($42,000). It may be substantially less on the foreign market.

The effluent from the color removal plant is pumped to the sand and gravel filters. This installation is quite similar to the ordinary water treatment plant sand filters. There are 22 sand filters in a very long building and four additional units are being added. Each filter is divided into two sections containing about 3.28 feet of gravel, 3.28 feet of sand and 3.28 feet of freeboard. The alum sludge carryover presents a problem in that it coats the sand particles making it difficult to clean the sand. To partially overcome this problem, the new units are being equipped with surface water jet agitators. We were told that the sand had to be replaced at least once a year which is a difficult task and very expensive. This process has not operated without a great deal of difficulty and has caused more operational problems than any of the other units. After 7 to 8 hours of operation at a rate of 26 ft/hour, the filters are backwashed. The backwash goes to the alum clarifiers and the clear water goes to the final settling lagoon having a volume of 21 million gallons. They are thinking of putting this lagoon ahead of the sand and gravel filters to reduce the load on the filters. After the settling lagoon, the effluent goes to a final aerated basin having a capacity of 16 million gallons.

They have allocated 7 million rubles ($9.8 million) to construct a plant to dewater the alum sludge and regenerate the alum. I am assuming that this facility, which is presently under construction, will be quite similar to the Gulf States' regeneration plant. Upon completion of this part of the plant, the total investment in external wastewater treatment facilities will be 37 million rubles ($51.8 million).

The two final polishing lagoons (settling and aeration) operated in series provide a retention of about 7 hours. One has been in operation since 1969 and will be cleaned this summer. Turbine aerators were initially used but have been replaced with pipe aerators. The dissolved oxygen leaving the aeration basin is about 8 ppm.

The final effluent is discharged by means of two outfalls into Lake Baikal. One is 525 feet from shore and the other is 262 feet from shore. Each pipe has two discharge outlets which discharge into a depth of 98 feet. The outfalls were designed for an initial dilution of 20, whereas they are actually getting a dilution of 100. The final outlets are tapered to give a jet effect.

The final effluent is continuously monitored by the Hydrometeorological Institute which has a station at the Baikalsk Mill.

They also have a very large lagoon for impounding the wet flyash from the power boiler scrubbers. They use about a 1000 tons/day of coal containing 17% ash and about 6% sulfur.

The general impression gained in touring the facilities was similar to our experience at Bratsk. Although the mill was relatively new, the buildings and concrete work was already falling apart.

Overdesign of the treatment facilities was also quite apparent and equivalent effluent quality could probably be achieved at half the capital investment if more attention were paid to internal measures of waste reduction. This overdesign is undoubtedly provided to compensate for internal problems and to ensure the discharge of a uniform well stabilized effluent.

Considering the great amount of money spent, the final effluent is not of drinking water quality and still contains taste, odor and color.

It is apparent that the mill management and plant operators take a high interest in the operation of the treatment facilities and a good job is done to produce a good effluent. There is competition between shifts to produce the best quality of effluent. This interest was shown at all Soviet plants. It appeared that more attention was paid to effluent quality than pulp and paper quality. External waste treatment is given high priority.

Tests conducted in the Lake indicate that no significant effect upon the Lake has resulted from the discharge of the Baikalsk effluent.

1. Monitoring at the Baikalsk Mill: Monitoring of the final effluent is conducted by the Hydrochemical Section of the Hydrometeorological Institute. This group is located at the mill and is working in the following two areas: (1) control of effluents entering Lake Baikal and (2) an estimate of the impact of the discharge on Lake Baikal (chemical and biological indices). They continuously monitor total solids, pH, sodium ion, redox potential, dissolved oxygen and temperature. In addition, 2 to 4 samples are taken per day which undergo more complete analyses. The information obtained is relayed to the mill manager and to the various governmental agencies having an interest in the Lake.

   The impact on Lake Baikal is also determined at numerous stations near the outfalls. Intensive sampling is conducted in an area of about 8 square miles near the outfall. In addition, they have a

number of sampling traverses in the Lake at substantial distances from the mill. Surveys of the Lake are conducted during the whole year. Special equipment is used in the winter such as half-tracks. Summer surveys are conducted by boat. Segments of the field study have been underway since 1967 and the biological survey has been underway since 1972 (bottom sampling since 1971).

The affected zone has come to equilibrium as shown by bottom sampling and is estimated to cover an area of 0.8 square miles. In this area there has been some measurable change in the chemical composition of the bottom deposits. There has been some measurable changes in the biological composition of the bottom in an area of about 2200 square feet near the outfall. Traces of the effluent can be detected by sensitive chemical tests in an area of about 6 square miles around the outfall. When compared to the inflow of natural inorganic and organic pollutants from the more than 300 streams entering the Lake, the mill's contribution is indeed miniscule.

The effluent limits for Lake Baikal and the actual concentrations discharged are shown in the following table:

	Requirements	Actual Mill Discharge
BOD, ppm	6	2 to 3
Suspended Solids, ppm	10	5 to 7
COD, ppm	150	70
Color, (color units)	100	63
DO, ppm	4	6 to 8
Phenolic Compounds, ppm	0.01	0.01
Organic Sulfur, ppm	0.5	0.2

In addition to the work underway by Hydromet, the Ministry of the Pulp and Paper Industry has also established a laboratory at the site headed by Dr. Beim. This group is studying the effect of various components of the effluent on several groups of organisms indigenous to Lake Baikal. In addition, field studies are underway using live boxes. Live boxes have been placed in the final aeration pond at the mill and at various locations in Lake Baikal.

Studies conducted to date indicate that all of the sensitive organisms studied can live in the effluent for at least 30 days, the duration of the tests. These tests include bioassays on the Omul.

Dr. Beim estimates that his studies will be completed in about one to two years. The maximum allowable limits presently in use (fishery requires) are shown in Table I.

2. Discharges into Lake Baikal: To get some idea of the discharges from this mill, we have calculated the pounds of materials actually being discharged* and they are as follows:

	lb/day	lb/ton
BOD	1,901	3
Suspended Solids	4,437	7
COD	44,370	70
Color	40,000	63

* Loads based on a daily flow of 76 MGD.

Although the above loads are quite low, it should be noted that there are several bleached kraft mills in the U.S. that are probably producing comparable results. A ritual performed at the treatment plant involves drinking of the final effluent. What exactly is proven by this subjective test is difficult to determine. We did notice, however, that the effluent tasted like pulp and paper mill effluent, had substantial color and was not a suitable supply for drinking water.

I. Meeting with Hydrometeorological Institute (Hydromet), Moscow (Wednesday, April 23, 1975)

We met with Mr. Tsatura, Chief Engineer for the Hydrometeorological Institute in Moscow, to review their program. Hydromet observes some 850 water bodies in the Soviet Union and has established some 2500 sampling cross sections. About 130 sea areas are included in their survey program. Samples are collected at these various stations several times per month. Analyses conducted depend upon the water body and the pollutants being discharged to the receiving water.

Information collected is sent to those ministries or institutes interested in the information on a monthly and annual basis. Hydromet has its own laboratories and mobile laboratories which are used throughout the Soviet Union.

They are presently expending considerable effort on continuous or automatic monitoring systems. A pilot system is under construction which will continuously monitor and telemeter several parameters to a control station. Those parameters which will be monitored are as follows:

dissolved oxygen, suspended solids, conductivity, redox potential, flow, temperature, copper, and pH. The pilot system will be started in 1976 and the experimental study will be underway for about two years. This will serve as the prototype for subsequent units.

Hydromet only monitors pollution. If serious pollution occurs, they notify the local authorities. They have no authority other than to recommend that corrective action be taken. Regional Hydromet offices are located throughout the Soviet Union (about 30 regional offices). They also have ocean vessels for sea monitoring and about 100 laboratories for analyses of water samples. They employ about 2000 people who are involved in air, water and soil analyses. About 50% of these people are involved with water pollution assessment.

Work is underway to develop a standard method for the analyses of water and waste effluent. Although some work is underway on the monitoring of ambient air, the work appears to be in its infancy.

J. Kherson Pulp and Paper Mill, Kherson, Ukraine (Friday, April 25)

This mill is located about five miles from Kherson in the Dnieper River delta and dates back to 1964. It was initially designed to use the reeds which grow in the Dnieper River delta but it was soon discovered that collection, transportation, and storage of this raw material presented insurmountable problems. The mill now uses Aspen which is obtained from a radius of about 400 to 500 miles from the mill (rail transport). Present capacity is about 33,000 tons/year of bleached market pulp and 11,000 tons/year of filter paper. Plans now call for adding a machine to produce paper for the production of a Formica-like product. The treatment facilities were built sufficiently large to handle any subsequent expansion. The present treatment facilities can handle 2 to 3 times the present waste load.

The mill employs about 1000 people and about 46 of the total are employed in the waste treatment plant.

The water supply comes from the Dnieper River and water usage is about 6.6 MGD. They use a six pass pandia digester and have a 4-stage bleach plant consisting of chlorination, caustic extraction, two stages of hypo, and sulfur dioxide treatment. The pulp has a GE brightness of 85 to 87%. A Flak drier produces about 99 tons/day of market pulp and a small machine produces 31 tons/day of filter paper.

Again, the treatment plant was quite elaborate and designed for a much larger load. Only half of the dual train plant was used. There were two radial grit chambers for the removal of sand. The grit was taken to landfills.

Primary treatment consisted of six 92 ft. diameter circular clarifiers. Incoming suspended solids were about 100 to 150 ppm and primary treatment removed about 70 to 75% of the suspended solids. The sludge is pumped to a sludge disposal area (27 acres). Waste activated sludge is also pumped to this disposal area since it is mixed with the primary sludge. The supernatant from the sludge storage lagoons is pumped back to the primary system.

The primary effluent then flows to two aerated equilizer tanks having a total capacity of 3.2 million gallons. Each equilizer has two sections which can be operated independently. A pipe aeration system is used in these tanks. Nutrients are added prior to the equilizer as ammonium sulfate and ammonium phosphate.

The effluents then combine in a very large mixing tank and flow into the activated sludge aeration tanks (2 units). The total capacity of these aeration basins is 7.4 million gallons. Air diffusion is by porous plates mounted on the bottom of the aeration tanks. Mixed liquor solids carried in the aeration tank are about 800 ppm and the return sludge is about 3400 ppm. About 11 hours of residence time is now provided in the aeration basin. Air is supplied at a rate of 1.34 cu. ft/gal of influent including the air for the equilizer.

There are four final secondary clarifiers (92 ft. diameter). The activated sludge from the secondary clarifiers is returned to the equilizer and activated sludge basin and the remainder is returned to the primary units.

The treated effluent is discharged into a reed area where additional BOD reduction is accomplished. The final BOD is about 5 ppm (275 lbs/day). An aerated stabilization basin is being added because they have been asked by the authorities to reduce their BOD load to 1 to 2 ppm. When asked why additional treatment was required, they were unable to provide an answer. When asked, why with all the additional capacity, they didn't use that instead of adding new facilities, we were told that this capacity was needed for the new paper machines.

The present treatment plant receives a BOD of about 150 to 200 ppm and overall BOD reduction averages about 96%. The suspended solids concentration is reduced from 100 to 150 ppm to an average of 20 ppm.

They have five very large air compressors each having a capacity of about 9500 cfm. Only one compressor is being used. The plant has been in operation since April 1973 and no major difficulties have been experienced. A large laboratory is available in the waste treatment building which is equipped to do microbiological and chemical testing.

Again, the treatment facilities were quite similar to those seen at the other mills. Concrete work and buildings were very poorly constructed and deterioration of concrete was noted everywhere.

Overdesign, as in the other plants, was also evident. Capacity was provided to meet any possible contingency.

Great care and attention was given to the production of a good effluent and this operation was given high priority.

We noted at all of the mills that treatment plants were built when the mill was started that would handle the load anticipated from any future expansion although this expansion might be ten years off. Considerable capital is being tied up in facilities that are not needed. If plants were built in increments, additions could be provided as required.

The additional capacity added to handle all internal mill problems also ties up considerable capital. We were told that the present Kherson treatment plant, exclusive of the addition, cost about 4 million rubles or $5.6 million.

K. Meeting with Ministry of Pulp and Paper Industry, Moscow (Sunday, April 27, 1975).

A final meeting was held with Ministry staff on Sunday morning in which we presented a list of possible areas which could be suitable for cooperative studies between the two countries. Based upon our tour, we came up with six areas which were as follows:

1. dewatering, utilization, and disposal of sludge,
2. decolorization of wastewaters,
3. evaluation of alternative biotreatment systems,
4. development of water quality requirements based upon the impact of the effluents on the receiving waters,
5. development of analytical methods for use in monitoring our effluents, and
6. reduction of wastewater volume.

Several approaches were suggested for accomplishing the above objectives and they were as follows:

1. exchange of research reports,
2. periodic meetings of selected experts to discuss various environmental problems, and
3. exchange of personnel to work on specific problems.

Further discussions will be conducted between the Environmental Protection Agency and the Ministry to work out an agreement before the end of the year.

Herman R Amberg

HERMAN R. AMBERG/jd
ESD:Camas